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6.4A TESTING AND OPTIMIZING MST COAXIAL COLLINEAR ARRAYS

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INTRODUCTION

Many clear-air VHF radar wind profilers use coaxial collinear (COCO) arrays for their antenna. A COCO array is composed of long lines of half-wave dipoles spaced one-half wavelength apart. In this paper we describe an inexpensive method of checking a COCO array and optimizing its performance by measuring and then correcting the relative rf phase among its lines at their feed point. This method also gives an estimate of the rf current amplitude among the lines. Therefore, the strength and location of the sidelobes in the H plane of the array can be estimated.

The only nonstandard equipment needed for these measurements is a probe to detect the rf signal near a radiating element. We use a short dipole 40 cm long tuned to the operating frequency by a variable inductor. Although the measurements described here were all made at the Sunset radar site, similar tests have been made at the Platteville, Craig, and Ponape radar sites, and could be made easily on any COCO array.

SUNSET RADAR ANTENNA

Figure 1 shows the distribution of rf power from the transmission feedline to each antenna element. The transmission feedline is a low-loss five-inch air dielectric; it enters a small well-screened building located in the center of the antenna where it feeds a harness. This harness divides the rf power into 16 equal parts, which are fed into 16 phase shifter boxes. The phase shifters are controlled remotely by an on-line computer. For a given tilt angle and direction, the computer selects either of two arrays and computes the phase shift required for each of the 16 phase shifters to produce the desired phase shift across the array (GREEN et al., 1984). Since a line of an array is composed of two strings of dipoles each with its own feed, the rf power output from each phase shifter is divided into half, and fed into a patch panel. This patch panel is actually one wall of the building. The antenna feedlines are attached to the panel on the outside of the building.

The antenna at the Sunset radar site is currently two colocated square arrays; one steerable in the east-west vertical plane (denoted E-W array), and the other steerable in the north-south vertical plane (denoted N-S array). Figure 2 is a plane view of the antenna. Each array is a coaxial collinear array composed of 16 lines of half-wave dipoles. These lines are spaced one-half wavelength apart, and are one-quarter wavelength above a ground plane. Physically, each line of the array consists of two strings of dipoles constructed from RG-8 coaxial cable by interchanging the inner-conductor with the braid at half wavelength intervals (BALSLEY and ECKLUND, 1972). Each string contains 12 half-wave dipoles, six on each side of its feedline, giving 24 dipoles in each line of an array.

MEASUREMENT PROCEDURE

It is important to make the measurements under conditions as close to the actual radar operating environment as possible; therefore all parts of the power distribution system and antenna elements are excited during the measurements. A signal generator feeds three watts of rf power at the operating fre-

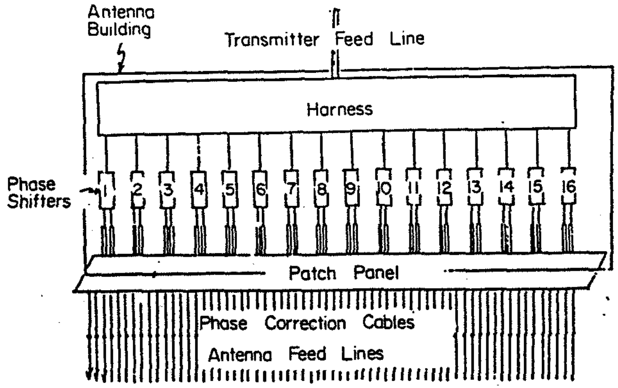

Figure 1. Schematic diagram of rf power distribution for the Sunset radar.

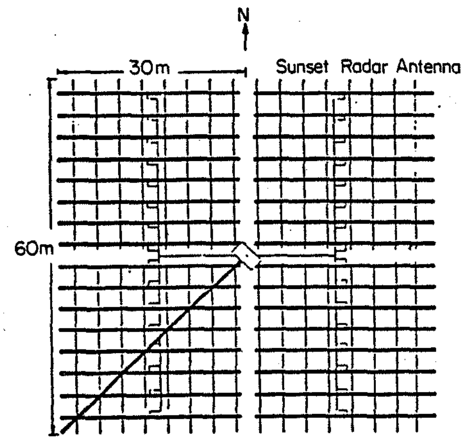

Figure 2. Plan view of Sunset radar antenna.

quency (40.475 MHz) into the front end of the transmission feedline. We place the short dipole probe a few inches from the first string of dipoles at its feedpoint. One end of a long RG-8 feedline is attached to the probe; the other end is connected to a vector voltmeter in the antenna building. We compare the rf signal from the probe with a convenient reference from the patch panel. After the amplitude and phase are measured with the vector voltmeter and recorded, the probe is moved carefully to the next string, and the measurements continued until all 32 strings of an array have been measured. Periodically, we return the probe to the first string to confirm the reproducibility of the measurements. Next we correct the relative phases among the strings by adding a correction cable to each feedline at the patch panel. Finally, we remeasure the entire corrected antenna.

RESULTS

The first, and perhaps the most useful, result is that these measurements provide a continuity test of the entire system from the transmission feedline to the strings of dipoles. At Sunset there are more than 1500 connections in this system; defective or missing components or interchanged connections are found easily. Furthermore, periodic testing allows the performance of the system to be monitored.

Next, we compare the uncorrected and corrected antennas. Figure 3 shows three broadside antenna patterns in the H plane of the E-W array. The first pattern (Figure 3a) is computed from the measurements made before the correction cables were added. It has large broad sidelobes; the largest sidelobe is only 10 bd below the main beam. The second pattern (Figure 3b) is the corrected pattern; its sidelobes are small and narrow similar to the ideal pattern shown in Figure 3c. These sidelobes reduce considerably the radar horizon for clutter, airplanes, meteors, and other competing targets.

REFERENCES

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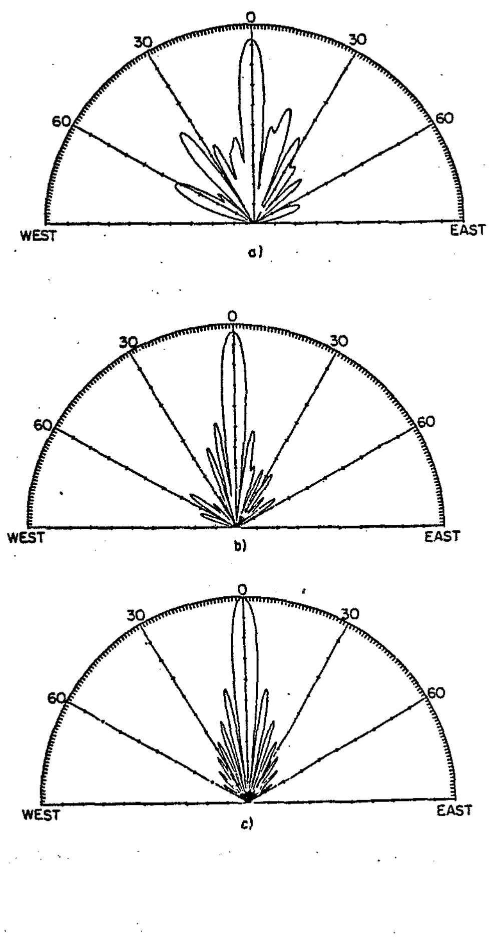

Figure 3. Broadside antenna patterns in H plane. The tick marks on the radial axis are separated by 3 dB for one-way propagation and 6 dB for two-way propagation. a) Pattern calculated from phase and relative power measured before phase correction cables are added.
b) Pattern calculated from phase and relative power measured after phase correction cables were added.
c) Ideal pattern.